THE GYROSTATIC COMPASS.[1]

MESSRS. ELLIOT BROTHERS, the English makers of the Anschütz gyro compass, are to be congratulated on the publication of an admirable account of the principle, construction, and practical use of this, the newest and most marvellous of all applications of the gyrostatic principle to a useful purpose. This book is chiefly translated from the German publication by Anschütz and Co., but the more mathematical part, due originally to Herr M. Schuler, has been modified by Mr. Harold Crabtree and Mr. Alfred Lodge so as to be more in accord with English mathematical usage. Commander Chetwynd and Commander Marston have also assisted in making those parts which deal with practice as useful as possible. With such skilled collaboration and with so admirable an original to work upon, it is not surprising that the result is so charming and instructive.

A gyrostat may be supported so that it has three (angular) degrees of freedom, or so that it has only two, one angular motion being constrained. With three degrees of freedom and really perfect balance the axis of rotation would maintain itself indefinitely in space and so the axis of rotation, if it were set parallel to the earth's axis, for instance, at any time and place would, rotation being maintained, retain that parallelism indefinitely, and show both latitude and the ship's course. The trouble is partly the difficulty of obtaining sufficient gyrostatic stability, but chiefly the impossibility of obtaining a really perfect balance, and so, however small the turning couple due to want of balance may be, precession will be set up and a cumulative error will grow and make the indications useless. If, however, the axis of a gyrostat is subjected to an elastic constraint tending to keep it level, but allowing it to tilt in spite of the constraint and if, further, the gyrostat is supported so that no couple acts upon it in azimuth as resulting from the support, then with sufficient gyrostatic capacity the whole combination cannot rest in any position except that in which the axis is pointing north and south very nearly, and the direction of rotation is in the same direction as that of the earth. For if the axis should be in any other direction the rotation of the earth will, through the elastic constraint, tend to elevate one end of the axis and depress the other, and under this constraint the axis will precess towards the north and south direction. When, however, this direction is reached, the axis will be neither exactly level nor at rest, and the motion would, like a pendulum, continue as far to the other side if some system of damping were not introduced.

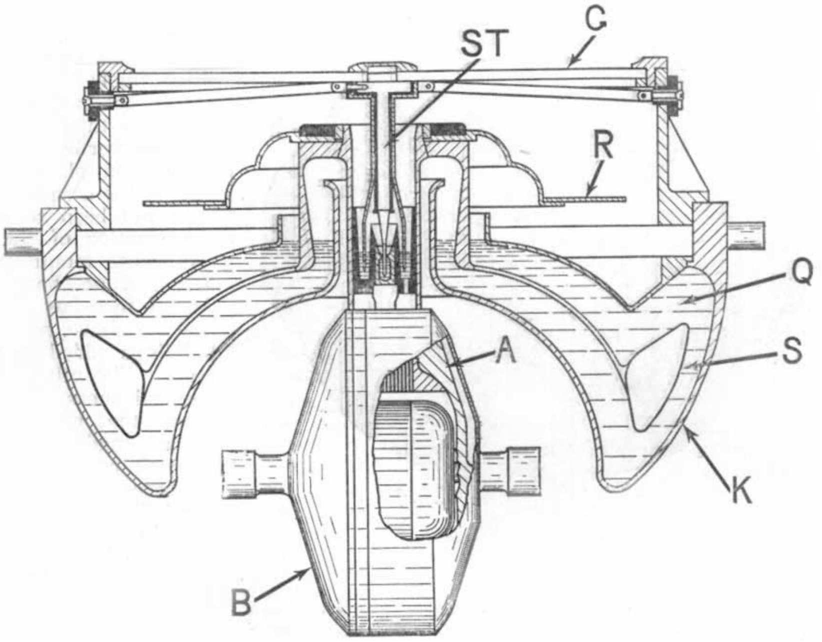

FIG. 1.—Vertical section through the centre of the gyro compass as constructed for use on board ship.

In the Anschütz gyro compass the gyro wheel is supported by a hollow steel ring immersed in mercury and with the centre of flotation a little above the centre of gravity, thus giving the necessary elastic constraint to the axis. The whole floating system (Fig. 1) is located by the compound piece, S, T, the two parts of which serve as two electric poles communicating with a three-phase motor within the gyro wheel A in the casing B. The compass card, R, is carried by the casing B. The third electric pole is supplied by the mercury, Q, and floating hollow ring, S, of steel. The whole case for the mercury, K, is carried on gymbal rings, like an ordinary compass. The gyro wheel, A, is run at a speed of 333 turns a second, and is subject to a bursting stress of 10 tons per square inch. Its axle, like that of a de Laval turbine, is sufficiently flexible to enable the wheel to establish its own dynamical axis, and it is supported on ball bearings of the highest perfection.

Beautiful as the invention is, closely as the material and construction approach perfection, perhaps no detail affords such a pleasing surprise as the system by which the damping of the motion, to which reference has been made, is effected. Side holes are provided in the casing, A, for the admission of air, and at the bottom there is a tangential opening through which a blast of hot air escapes. As something like half a horsepower is being absorbed within the casing, this air circulation affords the necessary cooling. The orifice, *a*, *b* (Fig. 2), for the escape of air is partly covered by a shutter, *u*, carried by a pendulum, so that when the gyro axle is horizontal the escape of air is symmetrical on either side of the shutter, but when it is inclined the escape of air is greater on that side on which the axle is elevated. The reaction due to the increased escape of air on one side tends to turn the casing round opposing the precession, and so bringing the axle towards the horizontal position. It therefore comes about that each excursion of the axle is only about one-fifth of the previous one in the opposite direction, and in about three hours from starting with axle level and 45° east or west, it has settled down steadily to its position of rest almost exactly due north and south.

Almost exactly, but not exactly; not that there is any vagueness as to the point of rest, but because there are certain corrections, a latitude correction, with which the little weight, *t*, has to do, and which

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[1] "The Anschütz Gyro Compass. History, Description, Theory. Practical Use." Pp. ii+109. (London: Elliott Brothers, 1910.)

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can be made thereby zero for any particular latitude in one hemisphere only. There is a second correction due to the ship's motion in latitude, small and independent of the particular instrument, and there is a third correction, a ballistic correction due to change in the ship's motion in latitude. Space does not admit of these being followed out, but they are fully explained.

The directive force of the gyrostatic compass is about fifteen times as great as that of an ordinary magnetic compass undisturbed by surrounding iron. In addition, therefore, to its being undisturbed by the magnetism of the ship or the movements of heavy magnetic pieces, such as guns, a master gyrostatic compass may be set up in a protected and quiet spot low down in the ship, and there control a number of dials placed in convenient positions for steering or for taking azimuth observations. These local dials are provided with central dials geared up thirty-six times, so that a complete turn corresponds to ten degrees. With such a compass to steer by and steering gear of greater precision than usual, the new compass should effect a saving in the actual distance run and in the horsepower at present wasted on the rudder, and it is an interesting question how long it will take for the reduction in the coal bill to pay for the compass.

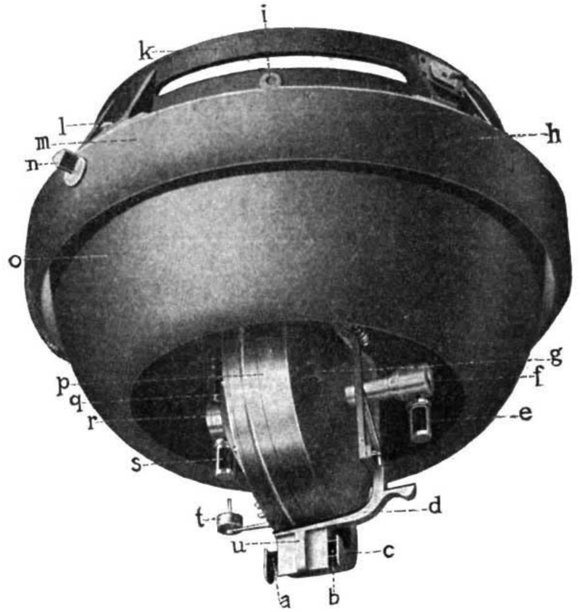

FIG. 2.—*a*, *b*, variable outlets for air blast; *c*, outlet pipe; *d*, pendulum arm; *e*, *s*, oil cup for gyro bearings; *f*, *r*, gyro bearings; *g*, inlet opening for air; *q*, terminal of gyro motor; *p*, gyro case; *o*, mercury bowl.

It is not possible owing to limitations of space to follow the numerous details relating to the theory, construction, and use of this beautiful instrument, but anyone with a sense of fine mechanics will appreciate this excellent exposition, even though he may never have the chance of running the compass himself.

C. V. BOYS.

THE PRESERVATION OF ANCIENT MONUMENTS.

THE report of the Inspector of Ancient Monuments for the year ending March 31, 1911, is the first by the new inspector, Mr. C. R. Peers. There are 104 monuments under the care of the Commissioners of Works, forty-eight in England and Wales and fifty-seven in Scotland. During the last year fifteen monuments have been placed under the protection of the Ancient Monuments Acts, ten in England and Wales and five in Scotland. Eight of the newly-protected monuments are situate in Anglesey, all prehistoric monuments, three of which have recently been astronomically surveyed by Sir Norman Lockyer and others. Of the two prehistoric Orkney monuments now under protection, the Chambered Mound of Maeshowe has received the attention of the same authority.

Useful linear measures are given of the monuments noticed in the report, and in one case, as a sort of nest-egg, we have the information that the bearing of the dolmen at Trefigneth "comes within one degree of the line of the winter solstice." Never a word is found referring to the available astronomical surveys, while it may safely be asserted that the formal protection of the Anglesey and Maeshowe monuments is largely due to the local interest awakened in the astronomical inquiry. In connection with the statement that "no adequate record has up to the present time been kept of the treatment of each monument year by year," surely the annual reports issued by the Pembrokeshire archæologists should have been mentioned.

"Certain observations of a general character" are most timely and important. "The first Ancient Monuments Act has now been in operation for twenty-nine years. Of the fifty-one prehistoric monuments scheduled by it as worthy of preservation by the State, twenty-six have been placed under its provisions, by the consent of the owners, while the rest, for various reasons, have not been so placed. In regard to these latter, the position of the State is entirely unsatisfactory, and these monuments are in a worse case than if they had not been noticed in the Act." The second Act of 1900 has a wider scope, with the grand result that we have now three castles and three monastic buildings added to the State waifs and strays! This report, like others of its kind, reveals the deplorable ineffectiveness of high-sounding measures. It also shows that where a scientific survey of a monument is first made and the results duly published, owners of such properties are among the first to recognise the necessity for effective protection. Lord Boston, Lord Sheffield, and Major Fox-Pitt have nobly led the way in Anglesey. The first and foremost factor in the case is scientific inspection, and monuments are best preserved in accurate measures.

JOHN GRIFFITH.

THE PORTSMOUTH MEETING OF THE BRITISH ASSOCIATION.

IN about six weeks' time, on August 30, the citizens of Portsmouth will have the privilege of welcoming the members of the British Association for their annual meeting. In many respects this meeting will be a contrast to that at Sheffield last year. Portsmouth cannot offer the attractions of large engineering works or manufactories, but at the same time it holds a unique position as the first naval port of the United Kingdom, and one of the most ancient of its boroughs. The borough of Portsmouth fifty or sixty years ago included only a small portion of the island of Portsea, on which the town is situated. There were walls and gates (which were closed every day at sunset) and a military governor. The walls are gone, but some of the old parts of the town are still well worth a visit. Three years ago the borough boundary was enlarged, now including the whole of the Island of Portsea.

Opportunity will be offered to members of the British Association to inspect the old corporation plate dating from Queen Elizabeth onward, and the old charters of the town, covering the last 500 years, can

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